The Impact of Computers on Documentation

By A. S. Douglas

Introduction

The most noticeable impact so far of computers on documentation has been to increase it in volume. It would perhaps have been more appropriate, therefore, to insert the word "potential" into the title before "impact," for this article does not concern the increase of documentation so much as methods of keeping documentation to a minimum and of improving its layout both for input to a computer and for use when produced as output by a computer.

Keeping Documentation to a Minimum

There are three basic types of document handled by a firm: those entering from outside, those leaving the firm, and those required internally. It is seldom possible for the firm to control the quantity of the first two, but the last can and should be controlled. If the quantity of incoming and outgoing documents cannot be controlled, their layout often can. When this is possible it is important to consider the reason for which the document exists and how it is to be handled within or outside the firm. We shall discuss this later.

Internal documents can be justified for two reasons only, namely control and record. Of these, in my opinion, control is the more important, although certain records are required for the purposes of tracing queries and preparing returns required by law. I shall say something about these later also.

Planning the Input Document Layouts

Documents used as a source for computer operations must be planned with some care. It must be borne in mind that basic information being put on them may be inserted by someone with little time to do it, and little or no incentive to ensure its correctness. Information required must therefore be kept simple and to a minimum. At the same time it is wise to provide for internal checks within the data, by which the correctness of entries can be tested.

Since the information is to be analysed in a computer, we may suppose some thought must be given to how the information is to be prepared for it. It is not essential to code the information, although it is often convenient to do so. Several techniques exist for simplifying both punching and coding, these having been developed particularly by firms engaged in market-research operations, which often demand large volumes of punching and coding to be undertaken. A technique which we have found useful is to use standard boxes to be filled in, as shown:

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the figures or letters being selected from a supplied list. Another technique is to set out a list of possible codes and invite the ringing of a particular one. This latter technique has proved most successful in registering University students (Windley, Kay and Rowland Jones, 1960).

The Content of Documents

It is, of course, especially important to ensure that the right questions are asked (or implied) on the document to obtain the information required. This necessitates a clear understanding, from the first, of what the information is to be used for once it is obtained. Nor is the position without subtlety, for the posing of a question may itself affect the actions of the person asked, and so invalidate the conclusions which it may be hoped to draw from the answer. This aspect of the problem is well understood in the field of advertising and marketing, but perhaps less clearly appreciated in other fields, so that I make no apology for drawing attention to it here.

The computer does not directly affect either the objective of the documentation or the way in which information is sought. Nevertheless, the range of analytical facilities which it can offer does affect the scope of inquiry which may be thought desirable. It is this consideration which has largely led to an increase in documentation up to now, since it has become easier and cheaper to analyse the data commonly available in a firm, and this has led to more analyses being done.

However, presentation of the new information has largely followed conventional lines, and the result has been to produce bigger and better tabulations, sometimes without consideration of the value of such an exercise. Much can be done in cutting down the volume of both input and output by the use of suitable statistical techniques. Not only could sufficiently accurate information for control purposes often be obtained by use of sampling procedures, rather than total analysis, but also more use could be made of computing facilities to compress the information analysed into a form suitable for digestion by management. In this connection there is considerable need for the provision of new equipment for visual

presentation of computer results, and I look forward to seeing the development of this in the near future.

Integration

Although I have indicated above several ways in which internal documentation may be cut down, these alone will not lead to a significant reduction in the volume of paper-work within a firm. Indeed, in some instances, the introduction of documents for control purposes will lead to a significant increase in documentation, since none exists at present in this context.

A more significant effect which can flow from the introduction of computers is the removal of the necessity for some internal documentation altogether. All large firms, and some small ones, are segmented for administrative purposes, since it is generally conceded to be inefficient to control centrally too large a unit. The result of this segmentation follows Parkinson's analysis (Parkinson, 1959), and leads to the necessity for each segment to pass information on the conduct of its affairs to the other in order that the division of control should not create total separation of operations. The introduction of mechanical procedures should remove the necessity for this information to pass in the form of documents. At the worst it should involve a pack of punched cards, at best it does not take place physically at all, but is incorporated in the computer program.

Where there is no physical division between activities, but there are notional divisions for administrative or other reasons, it should be possible to achieve integration now within the one computing system. In other circumstances perhaps the integration must wait upon further developments in the field of data transmission. It is possible to conceive of the operations of a firm as a unity, the inputs to which are the orders received, the raw materials to be processed, sales forecasts of future orders, and management objectives. Production planning and scheduling can be done largely by computational techniques, resulting in production documents (which may be, say, punched cards) which are used both to initiate and to keep track of production. The information obtained from this can be used to produce invoices and costs. From the latter, information can be derived to do estimating, and to provide figures for standard costing and other control procedures. This work can therefore also be dealt with by the computer without further documents being created for this purpose. In such a system, any documentation that is necessary over and above the original inputs is created largely by the computer itself, and in a form suitable for reabsorption by the computer later. In this way the volume of documents is reduced and the handling is simplified.

Auditing

There have been some objections raised to the integrated procedure described above, on the grounds that it will not be possible to audit the accounts produced by a computer unless all the present documents are printed out in full. This view I consider to be misguided. Strictly, I believe, it is adequate, for the purposes of external audit, that the auditor see only those documents coming into and going out of a firm, and the alleged overall accounts resulting from the trading implied by these documents. He need not concern himself with the details of how those accounts were built up, provided he can satisfy himself that they are substantiated by the documents available, and that these documents represent the whole operations of the firm. However, he must clearly be on his guard against fraud, and his techniques are based on the concept that criminals make mistakes in detail, and that these can be detected by experienced examiners of the detail.

The detailed examination is routine and can, in principle, be carried out by the computer itself. It should, therefore, be possible to construct the program in such a way that the auditor can satisfy himself that it is correct and contains adequate safeguards against fraud. He must then be satisfied that it is run correctly on the computer and cannot be tampered with without substantial collusion on the part of the accounting and programming staff. This is an organizational matter of little practical difficulty.

In so far as internal auditing is concerned, similar considerations apply, but there is no requirement to satisfy anyone other than management. Here I would make a plea for a more forward-looking view of the work of accountancy. Auditing is a backward-looking task and is designed to detect losses. For internal purposes a judgement should be made on the scale of losses it is worth detecting. There is no point in pursuing a loss of 15/- at the cost of £1. This is an instance where a statistical view of the situation would pay off in terms of reduction of cost and documentation. After all, the primary function of internal accounting is to provide management with information for the control of day to day operations, and for the projection of future plans, rather than for the investigation of events in the past, unless these are of special significance.

Conclusion

I began this discourse by asserting that computers have had little impact on documentation except to increase it. In my view this has come about because we have not yet begun to deploy the full power of computers in data processing, and thus their impact on documentation, as in other fields, has been limited. Let me conclude by asserting my belief that, over the next few years, much will change in both organization and documentation, due to a fuller and more efficient use of these powerful tools. I have tried to give some indications of the ways in which I expect these changes to take place. I do not expect many—or, indeed, any—of you to agree with my conclusions, but I think you will all agree that a reduction in the volume of documentation is essential if we are not to be snowed under with paper in the near future. In assessing recently the layout required for

using a large computer, my staff informed me that a fork-lift truck would be required to remove the paper produced by the output. It would indeed be a curious outcome of the introduction of computers into data processing if the sole result were to create a problem in paper disposal!

References

PARKINSON, C. NORTHCOTE (1959). *Parkinson's Law*, John Murray, London.
WINDLEY, P. F., KAY, L. R., and ROWLAND JONES, A. (1960). "Data Processing in University Administration," *The Computer Journal*, Vol. 3, p. 15.

Summary of Discussion

The Chairman Mr. C. W. Trow (*Vice-Principal, Northampton College*) had earlier said it was a disappointment that Mr. T. Cauter, who was listed on the programme to present the paper, was unable to be present, through indisposition. They were fortunate in having, in his place, *Dr. Alexander Douglas*, the Director of Technical Services in the same organization. He had had a long and distinguished career in the sphere under discussion at Cambridge and Leeds, and in the United States.

Mr. L. R. Crawley (*Standard Telephones & Cables Ltd.*) said Dr. Douglas must be fully alive to the problem which his own company had been studying from the form design point of view for some eighteen years, through which payrolls, costing and control had been made more efficient. It must be said, too, that H.M. Treasury had issued a very fine booklet on form design.

There was a tendency for computer manufacturers and those producing data-processing equipment to get companies to distort the lay-out of their forms in order to satisfy the limitations of the equipment they had to operate.

In the previous session there had been a question on the need to distort printed character shapes in order to make them acceptable to character recognition machines.

Dr. Douglas said he well knew that Standard Telephones and Cables had done a number of studies in those fields, but he did not believe they were fully aware of all the ramifications. He believed there was no case for any distortion in order to put material into the machine. He was arguing that the ends of business should be properly served without introducing any degree of distortion.

The use of most of the techniques he had mentioned had nothing to do directly with computers, being equally concerned in punched-card processing or even hand systems. The methods were generally accepted as sound from the operating point of view. He was concerned with making a balance between the work of those doing the recording and of those doing the input to the system; and he was particularly concerned with maintaining a proper balance in the light of what equipment was now available.

He was inclined to agree that there was no need for manufacturers to distort the requirements of business. He would go further and say the tendency of manufacturers to put problems into their own machines was itself a distortion of business procedures. The proper course was to examine the problem not from the point of view of the computer but from that of the company and its problems and to consider how the computer could help. He wanted to see such systems work as smoothly as possible and fit easily into the most appropriate computer processing; and if that meant changing the computer system, then he was quite sure there would be co-operation in that.

Mr. A. J. Mayne (*University of Leeds*) said that the new set-up made it possible for a manager to ask for special items of information, requested on the basis of data already obtained and displayed "the first time round." If a particular figure struck him as peculiar or unusual, he might wish to investigate it further; this could now be done easily, using modern computer methods.

There was one thing which a computer system could do—in principle, at least: it could provide the answers to a wide variety of questions which might occur to management after the first study had been made. There would be a much wider range of questions which, potentially, a computer was able to answer. But it would not answer all questions in practice, but only those of particular interest, as determined by some backward-and-forward arrangement between the computer system and the management. In that direction, considerable progress could be made.

There was a great problem in connection with information in industry and commerce; and there was equally a similar problem in scientific research. The problem of handling scientific documentation was itself one where computers would be able to help greatly. He was glad that serious efforts were at last being made to initiate extensive research in that direction, especially by the National Science Foundation of the U.S.A.

Mr. C. P. H. Marks (*Ministry of Aviation*) said he agreed with almost everything Dr. Douglas had said and had tried to "put across" those same arguments. One did not get very far though, because at the moment there seemed generally to be little faith amongst business people that those engaged in the field could in fact do what they claimed to be able to do. The dilemma was that ability could not be proved unless they were given the chance, and trusted to do the job; yet no one was prepared to trust them until they could prove their ability. This was something which many of us were up against at the present time.

Dr. Douglas had expressed very aptly that an office was now turning from a jobbing factory for paper work into a mass-production factory; and undoubtedly that was a cause of rigidity. He himself would not agree that the solution was to come with automatic programming and so on, because the nature of the rigidity was not the result of programming inadequacies. It was like a car factory when it was "jobbing": a customer could come in and look at his car as it was being built, say he did not like this or that and have it altered. It would be quite impossible for that to happen under a mass-production system. Certainly one could change the line, and keeping to the analogy, certainly one could change the program, but the flexibility to isolate and deal with a case in a non-standard way had gone.

Dr. Douglas said that was a particularly interesting aspect. It was a classical marketing problem best dealt with by the

efficient salesman. His own company had had some success in business in that area, although not in government in Britain. They had had success in the United States, also, and quite considerable success with government there. In the U.S. there was a rather different attitude in regard to government research matters being handled by private companies from that in Britain.

He agreed that some rigidity in data processing was not altogether undesirable. The difficulty was the classic one that the production-line operations in most businesses accounted for some 80% of the total market, the remaining 20% still being jobbing business, because it was not worth while for big operators touching that part of the field in which the customer had special needs.

Those who catered for that 20% usually had a hard time making a living and it was not profitable business by any standards. Big companies sometimes did it because they wished to keep their customers for some other reason; and that happened on even the biggest production run. He believed there was a possibility of satisfying both these worlds at once in data processing, if care was taken to introduce flexible procedures.

Every big operation must be set up as a production line operation but there was the problem that as the business underneath changed, so the roots changed. One of the real and quite fundamental problems in a programming system was that usually one thought one would be dealing with 80% of the documents in routine processing, the remainder being exceptions; so that there was a main line, with provision for the exceptions.

Although one regarded an exception in this sense as something handled infrequently, as one went through business one found that the exceptions became the rule, and the rule became the exception. That was a problem that had to be met on the programming side, where everything was geared to go down what was regarded as the direct line, exceptions being dealt with usually with less efficiency. That was not satisfactory because flexibility must be retained to permit exceptions, after a time, to become the rule.

It was for that reason that he believed automatic programming languages had an extraordinarily important part to play; because they would greatly simplify operational changes, although they would not remove all the troubles. These changes were themselves a nuisance but it was possible to do no more than minimize the impact on computing techniques. There he had a great deal of time for all the work that was being done in that direction, which he felt was of the utmost importance.

He did not expect to see a universal language produced within the next 20 years; he did not even know whether it would be a good thing if that did happen. His own view on languages was a simple one. He had never heard of any language which did not grow. Each language grew out of the necessities of the situation, through people, wishing to express particular ideas, adding to the language. It was basically a matter of expression and it was therefore nonsense to try to put language into a straitjacket. That attempt would quickly be undone.

It was right, within limits, for a great deal of the work in that direction to continue. But the language should not become as rigid as the system.

Mr. G. S. Dorey (*United Glass Limited*) said, speaking as an accountant who had long since ceased to practise that profession, he would take issue with Dr. Douglas on two matters, one of which was unconnected with it. First, Dr. Douglas believed that the most important aspect of business was production. In his own view that was not so. The most important aspect was sales, for it was no use being in business if one could not sell the product.

Secondly, there was the question of concern with the future rather than the past. Really, the accountants were on the side of Dr. Douglas, not against him. They had techniques like budgetary control and standard costing which were aimed at producing figures showing the results of forecasts and divergencies from them by means of variances. They faced exactly the same problems there as computer users; they had to get people to define what they wanted from their processing systems—whether it was an integrated data-processing system using a computer, or an accounting system expressing the results of business in financial terms. There was a great lack of knowledge of the techniques available for peering into the future. Did not much of the trouble lie in management not being taught as a science in Britain?

Dr. Douglas said he unhesitatingly agreed with the latter comment. Much of the trouble arose from lack of education and forward looking accounting, standard costing and budgetary control were things not universally adopted.

On the question of which was most important, clearly it was no good producing something which could not be sold. He agreed, too, that there was a very severe problem in the selling field. Basically, it was not a question of selling the item once one had it, but rather of forecasting what one ought to produce, and that was fundamental in all marketing procedures. Again, it was a sphere in which one might hope to use to advantage proper analyses of information that was at one's disposal—and not only past but present information, collected in the field by various means. In that area, speed was of the utmost importance and computers could give tremendous advantages. His own firm, he said, were engaged in putting together sales intelligence from various sources and trying to forecast what should be done next—something in which he felt sure computers ought to be involved. Clearly, control of production was a necessary part of the required information there, as well as such things as agents' reports and the general analysis of information on the sales side.

However, if production could not do without sales, equally sales could not do without production. It was equally bad whether one failed to sell the product one had or oversold that production. Accounting, as such, could not be separated from this aspect of sales and production. It was part of the information being produced in order to determine what goods (if any) should be produced.

Mr. C. C. Dilloway (*Ford Motor Company Ltd.*) said that the discussion was ranging over a wide field of documentation. He felt he must disagree with what had been said about the amount of paper passing between one company and another. The quantity suggested seemed too high.

Dr. Douglas had spoken against companies using a number of different computers. Dr. Douglas would appreciate that in their general operations large companies were split up into smaller units, and that progress could best be achieved within those lesser areas. It did not matter that different computers were being used in the early stages. Information was obtained on which long term plans could be based.

If people were told what type of computer they must have, little could be achieved. Statistical techniques were being very largely used in industry. It was becoming fashionable not to check all invoices or even the quantities of goods

received; and statistical control had been used for many years. There were some well-known examples of which Dr. Douglas would doubtless be aware.

The problem of flexibility in developing programs had been mentioned and he wished to draw attention to the great flexibility which could be achieved with a system of report generators. The reports which were produced for management on a regular routine basis were produced to a daily, weekly or monthly schedule, and when additional information was called for, the report generator program was used and it was possible to assemble the required information. Here an electronic computer was particularly flexible and was one way in which computers could be sold to management.

Dr. Douglas said there was a great deal in what had been said by Mr. Dilloway. He himself was aware of the difficulties within a firm and appreciated that it was desirable, in some cases, to allow things to grow from individual operation. But he would like to go a little deeper and look to the future in another area. The time scale on which information was passed to management was being changed and inevitably this would mean in the long term a complete change in the structure.

He did not believe that fragmentation into individual departments would necessarily survive in its present form once the computer system started to take over. With a centralized system the actual dimensions would start to change. The dimensions of a firm were very largely based on the amount that one man could effectively control through perhaps four or five others; and that whole situation was to alter.

There would be alterations in information, though at the present stage it was not possible to prophecy in what form. With such a changing situation very different ideas might grow up about centralization and the size of the individual units. Over the next few years these ideas might alter quite radically much of the operations of firms. It was not possible accurately to foresee what would be the overall effect, but from what was to be put into their hands, managements might get tighter control of their own business.

All this would mean an entirely different problem for management, something quite different from anything that had happened before. It was not only a change in the nature of doing things but a more substantial alteration and consequently he was not convinced that in the long run the barriers now thrown up round individual sections could be maintained, or that that would be advantageous.

Thought must be given to the central machine to go in, and how its arms were to stretch outwards; this raised the question of transmission speed. At present the amount of information obtainable overnight was less than one could get through the post in an envelope in the same time. In the U.S. the aeroplane had become a relatively cheap and fast data-transmission system. Data had been flown to New York for processing and flown back within 48 hours. There must be some bold thinking on all these aspects.

The Chairman, on behalf of those present, thanked Dr. Douglas for undertaking the lecture at short notice in place of Mr. T. Cauter, and for presenting it in so lucid and stimulating a fashion.

Book Review

Analogue Computation, by STANLEY FIFER, 1961. 4 vols., 1,331 pages total. (*McGraw-Hill Book Co., Inc.*)

This book, in four volumes, is intended to provide a complete course of instruction in analogue computing techniques at graduate or near-graduate level. The accent generally is on methods of computing rather than how to design computers, but even so, about a third of the book is devoted to describing and analysing equipment in order to give a proper understanding of machine limitations and sources of error. The care with which the author has defined his terms (e.g. "precision" and "accuracy") and the way the material has been arranged make this a good text-book for use in training establishments, particularly where an analogue computer is available to supplement book-work with practical work.

The first two volumes take the d.c. voltage analogue computer as an example and introduce first the units giving linear operations (summation and integration), then the methods of solving linear differential equations with these units. This is followed by a description of non-linear units (multipliers, resolvers, etc.) leading to a discussion of the solution of non-linear and variable-coefficient differential equations. Function generation by analytical series, transfer-function concepts and checking procedures are also covered. The text contains examples of various problems (e.g. interceptor kinematics) worked out in detail with their computer set-up, in order to demonstrate preferred computer arrangements and methods of scaling. Each chapter is followed by a reading list and problems (practical as well as theoretical, but no answers).

Volume III describes other types of analogue computer (a.c., network analyser, mechanical differential analyser, etc.) with typical problems for which they are suitable, although the treatment is not as exhaustive as in the case of the d.c. voltage analogue with which they are compared. In addition, the application of analogue computers to algebraic and partial differential equations is discussed.

Volume IV deals with advanced techniques which are necessary for many practical problems, for example harmonic analysis, noise, time delay and sampled-data control systems; a considerable amount of space is given to the dynamics of flight and flutter.

In view of the careful treatment of the subject there are one or two surprising (though minor) omissions. The importance of a stable reference, the effect of integrator capacitor imperfections on the harmonic oscillator simulation, and possibly some discussion of self-optimizing systems, could have been included with advantage.

The standard required to cope with Vols. I, II and III is covered in science and engineering graduate courses; the mathematics needed for Vol. IV may be a little more specialized in certain respects, but adequate references are given. The progression from Vol. I to Vol. IV is smooth, with a fine balance of theory and practice which should make for a good, if intensive, analogue computing course.

G. J. HERRING.